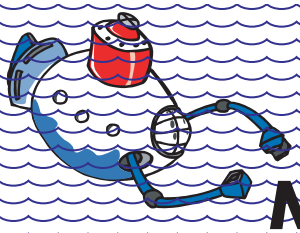

Meet the Arctic Benthos

Focus

Benthic invertebrate groups in the Arctic Ocean

Grade Level

7-8

Focus Question

What kinds of animals are found in the benthic community of the Arctic Ocean?

Learning Objectives

Students will be able to recognize and identify major groups found in the Arctic benthos.

Students will be able to describe common feeding strategies used by benthic animals in the Arctic Ocean.

Students will be able to discuss relationships between groups of animals in Arctic benthic communities.

Students will be able to discuss the importance of diversity in benthic communities.

Additional Information for Teachers of Deaf Students

In addition to the words listed as key words, the following words should be part of the vocabulary list.

Continental shelf
Chukchi Sea
Atlantic Ocean
Greenland Sea
Submarine ridges
Alpha Ridge
Lomonosov Ridge
Arctic Mid-Oceanic Ridge
Canadian Basin
Biological communities
Sea-ice realm
Diatoms
Algae
Photosynthesis
Bacteria
Viruses
Fungi
Energy source
Flatworms
Crustaceans
Jellyfishes
Squids
Detritus
Sponges
Polychaete worms
Sea anemones
Tunicates
Ascidians
Organism
Grabs
Dredges
Cores
ROPOS
ROV
Manipulator
Sampling
Relative abundance
Microscopic algae
Hydrothermal vents
Chemosynthesis
Silt
Biomass
Sediment
Carnivorous species

Benthic Realm
Biological communities
Food web
Invertebrates

There are no formal signs in American Sign Language for any of these words listed as key words and many are difficult to lipread. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful; however the list is quite long. It may also be helpful to have it available as a handout for the students.

It may take an additional 20-45 minutes to conduct this activity, depending on the students, familiarity with the topic and the vocabulary of the lesson. In the Background Information, beginning with Phylum Cnidaria, there is a description of invertebrate groups. This should be copied and given as a handout to assist students in this activity.

Create a worksheet with the requirements that the students need to include in the report.

Materials

- ❒ "Benthic Habitats" Sheet, either redrawn onto a blackboard, marker board or flip chart, or copied onto a transparency for use with an overhead projector
- ❒ Library or Internet access for research on Arctic invertebrates

Audio/Visual Materials

Blackboard, marker board, flip chart, or overhead projector and appropriate markers

Teaching Time

One or two 45-minute class periods, depending upon the amount of time spent on introductory material, plus time for students to do library or Internet research

Seating Arrangement

Classroom style

Maximum Number of Students

There are 18 groups to be studied. Students may work individually or in groups to complete the research activity. If the maximum desirable size for a group is four students or less, the activity could accommodate as many as 72 students in a single class.

Key Words

Pelagic
Benthic
Sympagic
Sessile
Anthozoa
Nemertea
Polychaeta
Echiurida
Ectoprocta
Bryozoa
Lophophore
Priapulida
Sipunculida
Cirripedia
Amphipoda
Cumacea
Isopoda
Pelecypoda
Gastropoda
Amphineura
Echinoidea

Holothuroidea
Ophiuroidea
Ascidiacea

Background Information

The Arctic Ocean is the smallest of the world's four ocean basins with a total area of about 5.4 million square miles or 14 million square kilometers (roughly 1.5 times the size of the United States). It is bordered by Greenland, Canada, Alaska, Norway, and Russia. The Arctic Ocean has the widest continental shelf of any ocean, extending 750 mi (1,210 km) from the coast of Siberia, but also has areas that are quite deep. The average depth is 12,000 ft (3,658 m) and the maximum depth is 17,850 ft (5,441 m). The Chukchi Sea provides a connection with the Pacific Ocean via the Bering Strait, but this connection is very narrow and shallow, so most water exchange is with the Atlantic Ocean via the Greenland Sea.

The floor of the Arctic Ocean is divided by three submarine ridges (Alpha Ridge, Lomonosov Ridge, and the Arctic Mid-Oceanic Ridge), one of which (the Lomonosov Ridge) creates a relatively isolated area known as the Canadian Basin. This area is particularly interesting to scientists, because its isolation could mean that it contains unique life forms that are found nowhere else on Earth. But the Arctic Ocean is not easily explored: it is almost entirely covered with ice for eight months of the year, a drifting polar ice pack covers the central and western portions year-round, and sea temperature seldom rises above 0 degrees C. Although the Arctic is still the world's least explored ocean, new expeditions are about to give us much greater knowledge of the mysteries of this polar frontier.

At this point, we know that there are at least three distinct biological communities in the Arctic Ocean. The Sea-Ice Realm includes plants and animals that live on, in, and just under the ice that floats on the ocean's surface. Because only 50% of this ice melts in the summer, ice flows can exist for many years and can reach a thickness of more than six ft (2 m). Sea ice is not usually solid like an ice cube, but is riddled with a network of tunnels called brine channels that range in size from microscopic (a few thousandths of a millimeter) to more than an inch in diameter. Diatoms and algae inhabit these channels and obtain energy from sunlight to produce biological material through photosynthesis. Bacteria, viruses, and fungi also inhabit the channels, and together with diatoms and algae provide an energy source (food) for flatworms, crustaceans, and other animals. This community of organisms is called sympagic, which means "ice-associated." Partial melting of sea ice during the summer months produces ponds on the ice surface that contain their own communities of organisms. Melting ice also releases organisms and nutrients that interact with the ocean water below the ice.

The Pelagic Realm includes organisms that live in the water column between the ocean surface and the bottom. Melting sea ice allows more light to enter the sea, and algae grow rapidly since the sun shines for 24 hours a day during the summer. These algae provide energy for a variety of floating animals (zooplankton) that include crustaceans and jellyfishes. Zooplank-ton, in turn, is the energy source for larger pelagic animals including fishes, squids, seals, and whales. When pelagic organisms die, they settle to the ocean bottom, and become the energy source

for inhabitants of the Benthic Realm. Sponges, bivalves, crustaceans, polychaete worms, sea anemones, bryozoans, tunicates, and ascidians are common members of Arctic benthic communities. These animals provide energy for bottom-feeding fishes, whales, and seals.

Most of our knowledge about biological communities in the Arctic Ocean comes from studies on portions of the ocean near the continental shelves. Very little research has been done on the sea ice, pelagic, and benthic realms in the deepest parts of the Arctic Ocean. These areas are the focus of the 2002 Ocean Exploration Program's Arctic Ocean Expedition.

This activity is focused on the Benthic Realm. Because the deep Arctic Ocean is virtually unexplored, the first questions researchers want to investigate are pretty basic: "What are the physical conditions of the Benthic Realm?," "What organisms make up the realm's biological communities?," and "How do these organisms obtain energy?" Research in shallower polar waters suggests that many different types of organisms are likely to be found, and that the majority of these will probably be invertebrates. These organisms are an essential part of Arctic Ocean food webs, and play a major role in recycling nutrients. This activity is intended to introduce students to major groups of invertebrates that have been found in other polar ocean expeditions, and to acquaint the students with the feeding habits of these animals as a basis for making inferences about benthic communities and their connection to other components of the Arctic Ocean ecosystem.

A brief description of major invertebrate groups that have been reported in previous studies of polar benthic communities follows. It is almost certain that other groups will also be found by expeditions to the deep Arctic Ocean, and it is quite possible that some organisms will be found that are new to science.

Phylum Cnidaria – Jellyfish, corals, sea anemones, and similar animals that have stinging cells called nematocysts. The Class Anthozoa, particularly sea anemones, is often abundant in polar benthic communities.

Phylum Nemertea (also known as Rhyncocoela and Nemertinea) – Their long flat shape gives these animals the common name "ribbon worms." These worms have no segments and are often predators.

Phylum Annelida (segmented worms) – The Class Polychaeta (worms with many appendages) has many representatives in polar benthic communities and is highly diverse in physical form as well as feeding strategy.

Phylum Echiurida (or Phylum Annelida, Class Echiura) – "spoon worms," that also live in burrows and are primarily deposit feeders

Phylum Ectoprocta (or Phylum Bryozoa, Subphylum Ectoprocta) – small, tube-dwelling animals that feed by means of a crown of tentacles called a lophophore

Phylum Priapulida – also called "penis worms;" mud-dwellers that resemble a little cucumber with teeth

Phylum Sipunculida – "peanut worms," which live in burrows or crevices; most eat

sand or mud and use whatever food material they may contain, but one species is carnivorous

Phylum Arthropoda (animals with a hard external skeleton and jointed appendages) – Four groups are common among the polar benthos; all belong to the class Crustacea:

Subclass Cirripedia – barnacles

Order Amphipoda – These laterally flattened arthropods employ a variety of feeding strategies and are the dominant group in many benthic communities.

Order Cumacea – These animals are usually quite small (1-4 mm long), but deep sea and Arctic species may be ten times as large, and live in burrows or mucous tubes in bottom mud.

Order Isopoda – Dorso-ventrally flattened arthropods resembling bugs; may be free-living or parasitic, but are never filter feeders.

Phylum Mollusca (invertebrates usually having a muscular foot and an external shell)

Class Pelecypoda – clams, which are all filter feeders

Class Gastropoda – snails, which have a variety of feeding strategies

Class Amphineura – chitons, which feed by scraping algae and other materials from hard surfaces

Phylum Echinodermata (invertebrates with a spiny skin)

Class Echinoidea – Sea urchins and sand dollars; sand dollars are often found in areas where strong currents make it difficult for other animals to live

Class Holothuroidea – Sea cucumbers

Class Ophiuroidea – Brittle stars

Phylum Chordata

Class Ascidiacea – "sea squirts," leathery-skinned bottom dwellers that grow singly or in colonies attached to stable surfaces

Learning Procedure

1. Assign one or more of the groups listed above to each student or student group. Have each group prepare a brief report on the assigned group(s) using library and/or Internet resources. Each report should include (a) a description of the animal including size range; (b) habitat; (c) food source(s) and feeding habits; and (d) an illustration, if possible. The following websites contain the necessary information:

http://library.thinkquest.org/26153/marine/animalia.htm
http://www.teachinhg-biomed.man.ac.uk/bs1999/bs146/biodiversity/metadiv.htm
http://tolweb.org/tree?group=Animals&contgroup=Eukaryotes
http://virtual.yosemite.cc.ca.us/randerson.Marine%20Invertebrates/index.htm
http://biodicac.bio.uottawa.ca – this site has lots of images suitable for downloading

2. Have each student or group present their report to the entire class. Redraw the "Benthic Habitat" sheet, or copy the sheet onto a transparency for use with an overhead projector. Have the students write the name of their group(s) in the appropriate habitat area, and indicate whether the animals are sessile (fixed in one place) or mobile.
3. Lead a discussion of how different benthic groups interact, with particular emphasis on

feeding strategies. Students should realize that these groups are adapted to obtain food from the benthic environment in a variety of ways, including filter feeding, deposit feeding, and predation upon other benthic organisms. Students should also realize that the primary source of food for benthic organisms is primary production that occurs in the sea ice and pelagic realms, and that organic material and nutrients are transported out of these environments when organisms die and settle to the bottom. Feeding activities by benthic organisms are an important process that returns some of these materials to other realms of the polar ocean environment. Ask students why they think there are so many different kinds of animals in these benthic communities, and why this diversity is important.

The BRIDGE Connection

www.vims.edu/BRIDGE/polar.html

The "Me" Connection

Have students write a brief essay on why diverse but relatively unknown groups, like those studied in this activity, are important to their own lives.

Connections to Other Subjects

English/Language Arts

Evaluation

Reports prepared in Step #1 may be submitted for grading on the basis of thoroughness in addressing the four content areas. It is also possible to create a matching or fill-in-the-blank identification quiz using images from http://biodicac.bio.uottawa.ca.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov to keep up to date with the real-time exploration of the deep Arctic Ocean, and to find out what organisms researchers actually find in the benthic realm.

2. Investigate the Shelf Basin Interactions (SBI) and Canadian Arctic Shelf Exchange Study (CASES) programs

Resources

http://oceanexplorer.noaa.gov – Follow the Arctic Ocean Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of information can also be found at this site.

http://www.arctic.noaa.gov – NOAA's Arctic theme page, with numerous links to other relevant sites

http://maps.grida.no/arctic/ – A site with many "theme" maps that show ecoregions, populations, geology, etc.

Grebmeier, J. M., H. M. Feder, and C. P. McRoy, 1989. Pelagic-benthic coupling on the shelf of the northern Bering and Chukchi Seas. II. Benthic community structure. Marine Ecology Progress Series 51:253-268. – Scientific journal article on which this activity is based

National Science Education Standards

Content Standard A: Science As Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard C: Life Science

- Populations and ecosystems
- Diversity and adaptations of organisms

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GENERALIZED BENTHIC HABITATS